

Decline of the urban Koala (*Phascolarctos cinereus*) population in Warringah Shire, Sydney

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ABSTRACT

The Koala population in Warringah Shire has declined over the last 50 years with increasing urbanization. Koalas were reported from various localities throughout the Shire in the 1940's, 1950's and 1960's. They now occur only at Barrenjoey Peninsula, Ku-ring-gai Chase National Park and, possibly, Davidson Park State Recreation Area. The colonies at Barrenjoey Peninsula and Ku-ring-gai Chase National Park have both declined in numbers and distribution since the 1970's. On Barrenjoey Peninsula, the main subject of this study, clearing for residential development has steadily reduced the area of forested land from about 705 ha (47% of the Peninsula north of Bungan Beach) in 1946 to about 125 ha (8%) in 1989. The Koala colony on the Peninsula has declined from an estimated 123+ Koalas in 1970 to only about eight Koalas in 1989. The remaining Koalas appear to use several Council bushland reserves as refuges: Angophora Reserve/Hudson Park, Stapleton Park, Careel Headland Reserve, Crown of Newport Reserve and, until 1988, Algona Reserve. The principal food tree on Barrenjoey Peninsula is Grey Gum, *Eucalyptus punctata*. Other important food trees are Scribbly Gum, *E. haemastoma*, and Swamp Mahogany, *E. robusta*. These food trees occur in low densities in the reserves compared with their former densities elsewhere on the Peninsula. The reserves have also suffered extensive eucalypt dieback associated with urban runoff, and their eucalypt communities are threatened by expansion of rainforest vegetation and Black She-oak, *Allocasuarina littoralis*, scrub. The chief threats to continued survival of the Peninsula's Koala colony are further loss of habitat, within as well as outside reserves, and further mortality from dogs, motor vehicles and the disease chlamydiosis. The limited information available suggests that dogs have been the chief cause of mortality on the Peninsula, in contrast to other urban colonies studied, where it has been motor vehicles and chlamydiosis. The incidence of chlamydiosis has been low but may pose a particular threat to the few remaining Koalas. The history of Koalas on Barrenjoey Peninsula illustrates how a carefully planned and managed reserve system is crucial for Koala conservation in urban areas. This must be established in the early stages of regional development. The deficiencies of the reserve system on Barrenjoey Peninsula pose enormous difficulties for rehabilitation of the Koala colony now.

INTRODUCTION

The occurrence of Koalas, *Phascolarctos cinereus*, in Warringah Shire is well known and not only locally. The colony on Barrenjoey Peninsula, in particular, has often been mentioned in the popular and scientific literature on Koalas (e.g., Williamson 1975; Winch 1977; Strahan and Martin 1982; Lee and Martin 1988). Koala numbers have dwindled with increasing urbanization and the future of the Barrenjoey Peninsula colony has been a matter of public concern for many years (e.g., Bulletin 17.ix.1958; Sydney Morning Herald 20.ix.1962, 1.ii.1979).

This study was commissioned by Warringah Shire Council to provide an information base on the Koala within the Shire, so that the impact of future developments could be assessed and appropriate measures taken to preserve the colony on Barrenjoey Peninsula. One objective of the study was to provide an historical overview of the past and present distribution of Koalas throughout the Shire. However, the emphasis of the study was on the Barrenjoey Peninsula colony: to determine their present numbers and distribution, the extent of available habitat on the Peninsula, and the problems facing the colony.

METHODS

Review of Existing Information

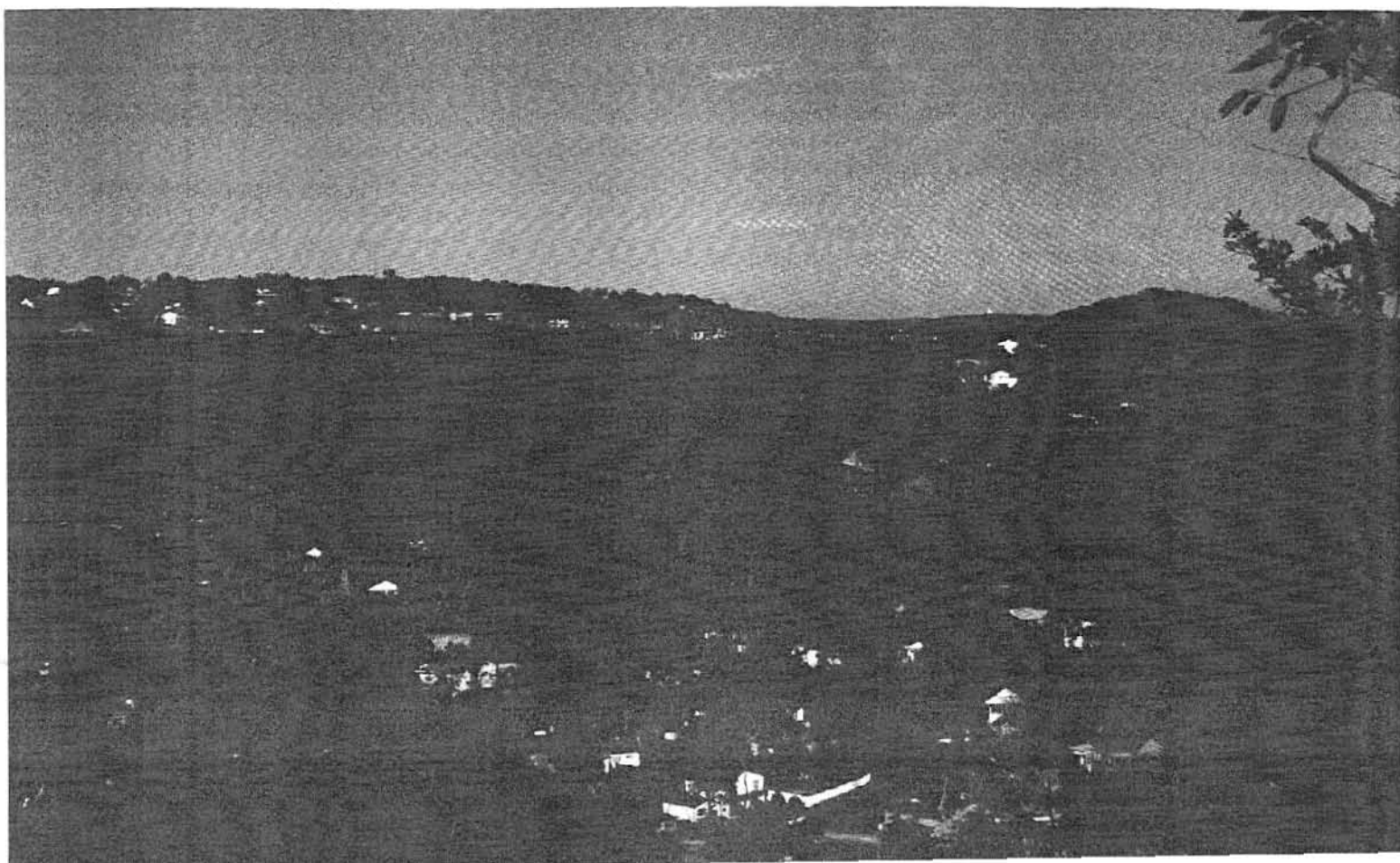
Previous Koala records in Warringah Shire were obtained from the following sources:

- The files of the New South Wales National Parks and Wildlife Service's Koala Research Officer, Philip Reed, including returns from State-wide surveys in 1949, 1967, 1975 and 1986/7, records from the State-wide WILDATA wildlife inventory programme, records from the North Metropolitan District's Wildlife Recording System, and an extensive compilation of newspaper clippings.
- Warringah Shire Council files, particularly the results of Koala surveys of Barrenjoey Peninsula by University of New England students under the direction of Council's Environmental Officer, Peter Smith, in April 1988 (Newton 1988) and December 1988 (Brown and Adair 1989).
- The files of the Avalon Preservation Trust.
- Records from a 1985 survey of Koalas at Avalon commissioned by Fund for Animals (Smith and Smith 1985).
- Files on sick or injured animals received by Taronga Zoo.



Photo 1. Koala in Dress Circle Road, Avalon, December 1988 (Photo by Kerry McInnes).

Photo 2. Avalon, looking south-west from Stapleton Park (Photo by Peter Smith).



Koala Survey

A questionnaire survey was conducted on Barrenjoey Peninsula in August 1989, seeking information from residents on their Koala sightings, both recent and past. About 11 000 forms were distributed to all homes on the Peninsula north of Bungan Beach. Another 3 000 forms were distributed to pupils of the five primary and secondary schools on the Peninsula. The survey was advertised through a series of press releases in the local newspaper, The Manly Daily. A total of 445 forms were returned.

Various searches were made of the Peninsula, both by day and by night, for Koalas, their calls, droppings and scratchmarks. However, no information was obtained from these searches additional to that obtained from the questionnaire survey.

Changes in Tree Cover

Changes in tree cover on the Peninsula since the 1940's were mapped from air photos taken at about 10-year intervals: 1946-47 Aerialphotos, 1955-56 Lands Photos, 1961-65 Lands Photos, 1977 Aerialphotos and 1986 Aerialphotos. Tree cover classes were mapped on photo overlays, which were then reduced to a standard scale and transferred to base maps.

Food Trees

To determine the food tree preferences of Koalas on Barrenjoey Peninsula, residents were asked in the questionnaire survey if they could point out trees in which Koalas had been seen. These trees were identified in follow-up interviews. Together with similar records from a previous survey (Smith and Smith 1985), they provided a sample of 154 different trees in which Koalas had been seen. Studies by Robbins and Russell (1978) and Hindell *et al.* (1985) have shown that the trees occupied by Koalas during the day are usually the trees in which they feed.

The distribution and density of potential food trees were investigated in 108 sample plots, 0.1 ha in area and 375 m apart in a grid arrangement covering the entire Peninsula north of Bungan Beach. In each plot, all eucalypts (species of *Eucalyptus* or *Angophora*) over 6 m were identified to species, classed as low (6-15 m) or tall (>15 m), healthy (<1/3 of the canopy dead) or unhealthy, and counted. Dead eucalypts were also counted but not stumps.

An additional 17 plots were located in the larger bushland reserves, increasing the sampling intensity to six plots in Angophora Reserve/Hudson Park, six plots in McKay Reserve/Dark Gully Park, four plots in Stapleton Park, four plots in the unnamed bushland reserves

around Bilgola Creek, two plots in the forested part of Careel Headland Reserve and two plots in Crown of Newport Reserve.

HISTORY OF KOALAS IN WARRINGAH SHIRE

1788-1899

Koalas were scarce around Sydney at the time of European settlement. Following Governor Phillip's arrival in 1788 a decade passed before the first reported sighting. The first specimen was not obtained until four years later and the first live animal not until the following year, 1803 (Iredale and Whitley 1934). Their apparent scarcity at this time has generally been attributed to heavy hunting pressure from the Aborigines, for whom they were a large and easily taken food item (Lee and Martin 1988).

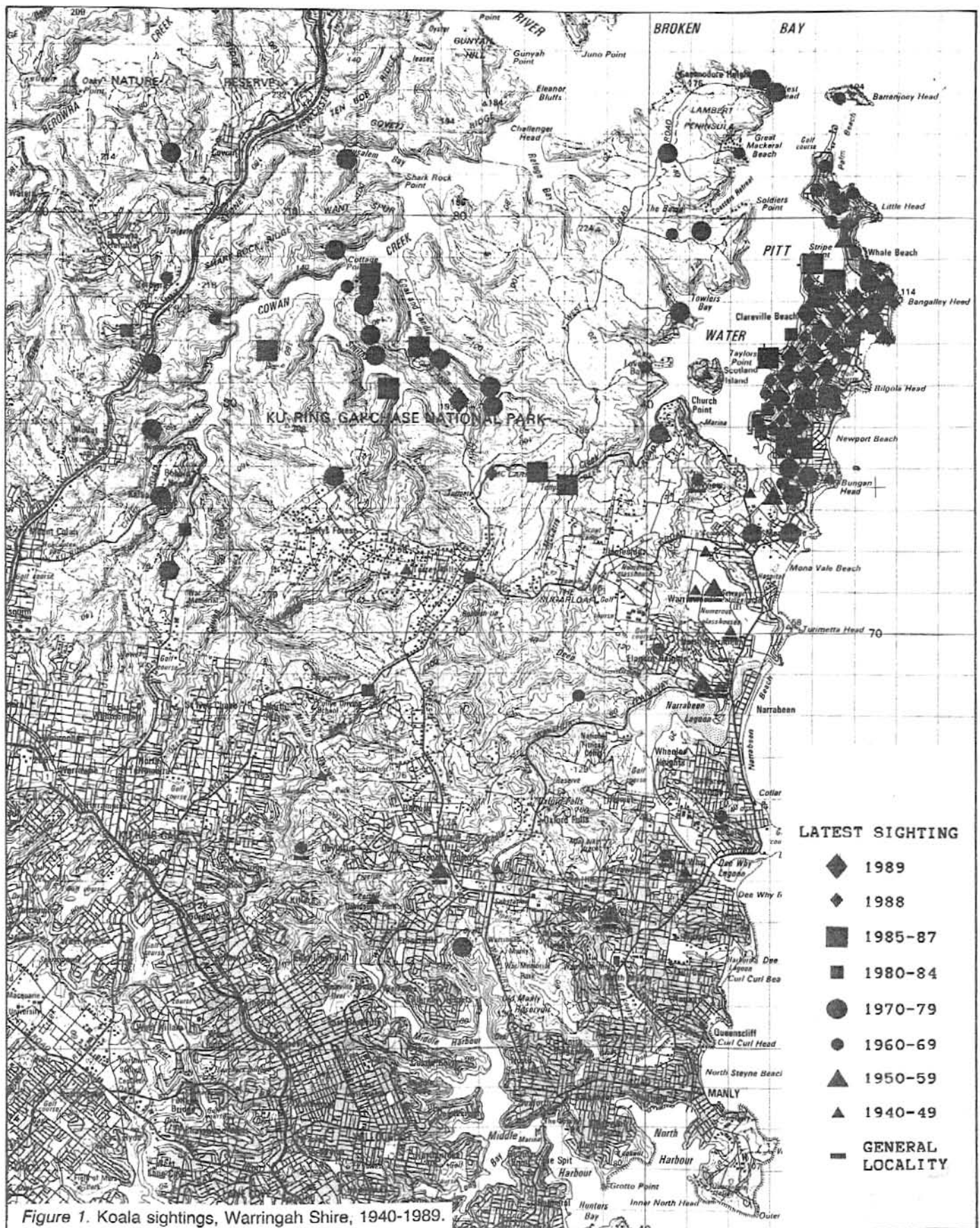
Reports of Koala numbers around Sydney in the 1830's are conflicting. Gould (1863) stated that Koalas were to be found at this time along the coast from Illawarra to Moreton Bay and "although nowhere very abundant, a pair, with sometimes the addition of a single young one, may, if diligently sought for be procured in every forest." Govett (1836), however, indicated that they were common: "They are generally found in thick stringy-bark forests, and are numerous on the ranges leading to Cox's River, below the mountain precipices, and also in the ravines which open into the Hawkesbury River, as well as in various other parts of the colony."

In subsequent decades, Koala numbers increased dramatically throughout eastern Australia, which has been attributed to the decline of their chief predators - Dingoes, *Canis familiaris dingo*, and especially, Aborigines (Parris 1948; Warneke 1978). The Koala was so abundant by the late 1870's that it became one of the staples of a major fur industry. Literally millions of Koalas were killed for their fur over the following 50 years (Lucas and Le Souef 1909; Pratt 1937).

In keeping with this general pattern, Koalas had become abundant in the northern suburbs of Sydney by 1890. David Stead (Sydney Morning Herald 25.iv.1929) recalled that "40 years ago there were as many native bears around Sydney as there are now in Queensland. I can recall seeing hundreds of them on the North Shore line and at Hawkesbury. At Lavender Bay there were many to be seen. They were also numerous at Taronga Park."

1900-1939

The Koala population in New South Wales collapsed around the turn of the century. In part, this was due to the heavy hunting pressure for the fur trade - for example, 600 000 Koala skins were purchased in New



South Wales in 1902 (Reed and Lunney 1990). However, there were a number of other factors involved in the Koala's demise. Disease epidemics "swept it off in millions in the years 1887-8-9 and from 1900 to 1903" (Le Souef *et al.* 1926). These epidemics are now believed to have been caused by the bacterium *Chlamydia psittaci*, which is prevalent in present-day Koala populations and responsible for a variety of diseases, collectively termed chlamydiosis (Brown *et al.* 1984; McColl *et al.* 1984; Brown and Carrick 1985). Other major factors were the severe droughts of the 1880's, 1890's and early 1900's (Foley 1957; Jeans 1972; Gordon *et al.* 1988; Reed and Lunney 1990) and the extensive clearing of forests and woodlands on more fertile soils, which supported the greatest numbers of Koalas (Wells *et al.* 1984; Lunney and Leary 1988; Reed and Lunney 1990; Reed *et al.* in press). Viewpoints differ on the relative importance of these different factors, although recent reviews have tended to emphasize the dominant influence of habitat loss in reducing and fragmenting Koala populations and increasing their susceptibility to drought and disease (Lunney *et al.* 1990; Lee *et al.* in press).

By the 1930's there was concern that the Koala was facing extinction in New South Wales, with several estimates of its total numbers in the State as low as 100-300 (Pratt 1937; Anon. 1938; Sydney Morning Herald 16.ix.1937, 22.xii.1938, 2.ix.1949). Although it is unlikely that the population ever reached such a low level, Koala numbers had certainly been much reduced in New South Wales. In contrast, Koalas remained abundant in Queensland, where almost 600 000 Koala skins were marketed as a result of a one-month open season (the last) in 1927 (Lee and Martin 1988).

Little information is available on Koalas in Warringah Shire between 1890 and 1940. Koalas were present and could be readily found behind Paradise Beach, Barrenjoey Peninsula, throughout this period (letter from B. Powell, whose family owned the land and who remembered the period 1924-34 in particular). Five Koalas were killed by cars on Barrenjoey Peninsula over an 18-month period in 1937-38 and the secretary of the Koala Club of Australia, F. Edwards, estimated that fewer than 30 Koalas remained in the area (Sydney Morning Herald 22.xii.1938). Further statistics on "koala tragedies" in the area (causes not stated) were: two killed in 1936, four in 1937, 10 in 1938 and 14 in 1939 (Koala Club of Australia 1940). The high figure for 1939 was possibly a result of a severe bushfire north of Newport in January of that year, reputed to be the worst local bushfire in living memory (Jennings 1987).

1940-1949

A State-wide questionnaire survey was undertaken by the newly formed Fauna Protection Panel of New South

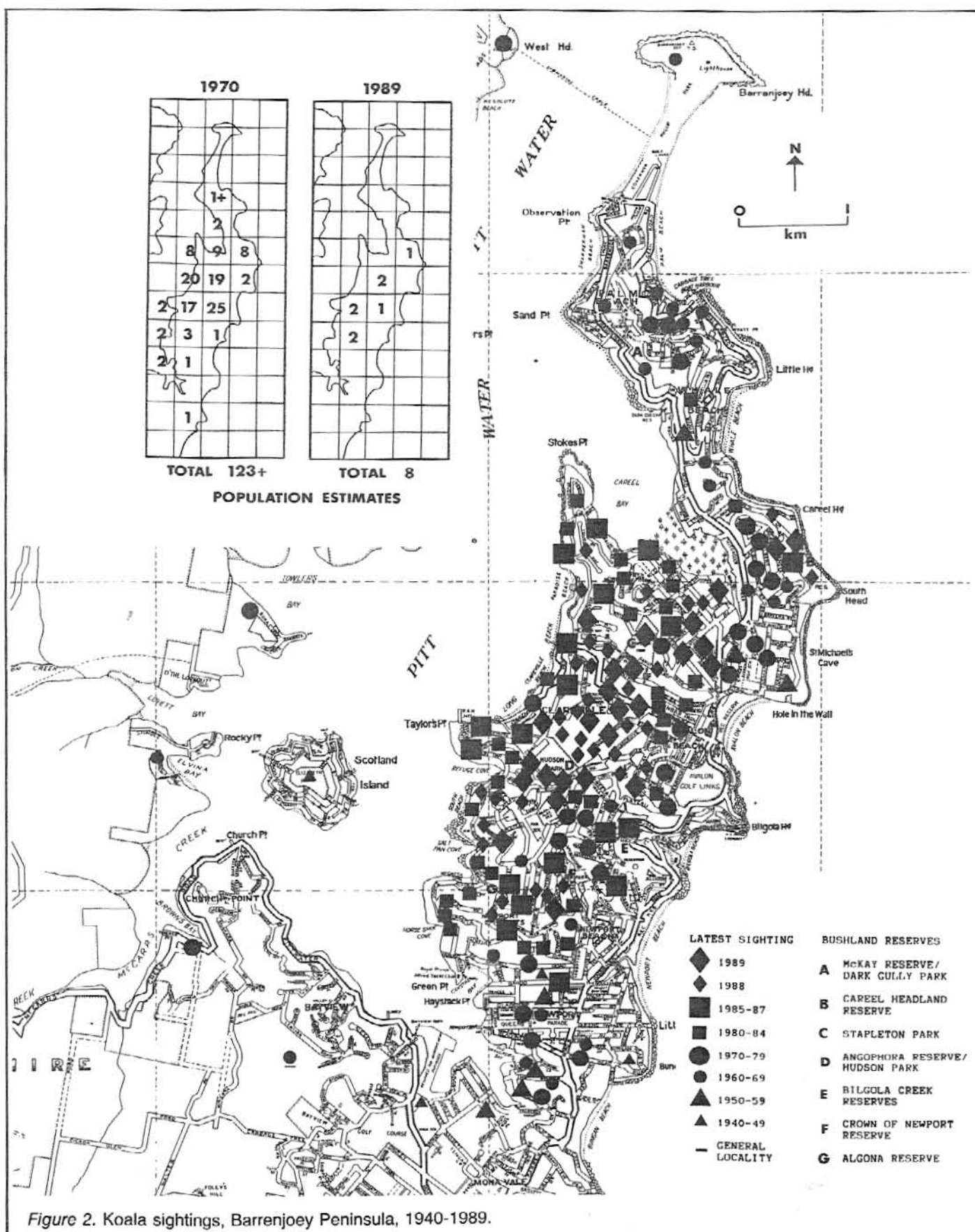
Wales in 1949, seeking reports of Koala colonies from government officers and from the public. The report of the survey concluded that "there appear to be some thousands of Koalas at present in the State... around Sydney there are a number of colonies, the most numerous being on the Barrenjoey Peninsula" (Parliament of New South Wales 1950; Reed *et al.* in press).

The original returns from the 1949 survey, supplemented by records of sick or injured Koalas taken to Taronga Zoo, provide a picture of the distribution of Koalas in Warringah Shire in the 1940's (Figures 1 and 2). Most records came from coastal areas, especially Barrenjoey Peninsula but also Mona Vale, Warriewood, North Narrabeen, Narrabeen and Dee Why. One respondent estimated that there were four or five families of Koalas living around Palm Grove, Avalon. Comments from other respondents suggest that several Koalas would usually be seen when holidaying in the Avalon area in the 1940's. Sightings were fewer in Palm Beach and Newport, and fewer again further south. For example, one resident of Vineyard Street, Mona Vale, noted that two or more Koalas would turn up about once a year, stay for less than a week, then leave.

A Koala colony was also reported at this time on Scotland Island. In this regard, it is known that Koalas can swim (Smith 1987) and one has even been seen swimming in Pittwater (reported to P. Reed, New South Wales National Parks and Wildlife Service). Further inland, there were reports of Koalas from Cottage Point, Terrey Hills, French's Forest and a couple of localities in Davidson Park. Two respondents noted that the Terrey Hills colony was declining. One estimated the former size (in 1940) of the "Terrey Hills-Cedar Point" (Cottage Point?) colony as 50 Koalas.

1950-1959

Until the early 1950's the major threats to Warringah's Koalas were generally perceived as bushfires, motor vehicles and dogs (e.g., Anon. 1938; Sydney Morning Herald 22.xii.1938, 6.ix.1950). The Fauna Protection Panel's report for the 1951-52 year remarked on how the disastrous bushfires of that summer had killed a number of Koalas in the French's Forest area, while the Narrabeen and Palm Beach area had been almost fire-free and the Koalas there had bred normally (Parliament of New South Wales 1952). The next few years saw the emergence of concern about a new threat - the loss of trees associated with extensive housing development in the Newport-Avalon-Palm Beach area (Parliament of New South Wales 1953, 1954). This has remained the chief concern ever since and has been repeatedly raised in the Sydney papers (e.g. Bulletin 17.ix.1958; Pacific Times 1.vi.1967, 26.vi.1969; Sunday Mirror 6.vii.1969;



Sydney Morning Herald 20.ix.1962, 1.ii.1979; Manly Daily 11.i.1979).

The boom in residential development after 1950 represented a new stage in the history of Barrenjoey Peninsula (McDonald *et al.* 1989). From the early 1800's to the 1880's, the area was sparsely populated and devoted to farming. Although there was extensive clearing of the fertile soils and gentler terrain on the eastern side of the Peninsula and at Mona Vale, the western side of the Peninsula remained forested. From the 1880's to the 1940's, public transport and access to the area gradually improved and it became a popular location for weekend and holiday homes. In the 1950's, however, as cars became more affordable and better roads were constructed, the Peninsula villages developed into dormitory suburbs of Sydney, with a huge increase in population. There was large-scale clearing of forested areas throughout the 1950's, 1960's and 1970's. The area of forested land on the Peninsula north of Bungan Beach has declined from about 705 ha (47% of the Peninsula) in 1946 to about 125 ha (8%) in 1989 (Figure 3).

In response to public concern about the effects of clearing, the Fauna Protection Panel carried out a survey of Koalas on Barrenjoey Peninsula in 1955 (Parliament of New South Wales 1955). The size of the population was estimated at about 120, with evidence of breeding and no signs of disease. It was concluded that the Koalas were undoubtedly threatened by increased clearing but with extensive tree planting and the creation of permanent reserves it should be possible to save the colony from extinction. The desire of local residents to preserve the Koalas resulted in the formation of the Avalon Fauna and Flora Protection League, which immediately organized the planting of some 600 eucalypts supplied by the Fauna Protection Panel. The League and its successor, the Avalon Preservation Trust, together with Warringah Shire Council, have been involved ever since in the distribution and planting of large numbers of young eucalypts in the area.

Koalas were widely, if sparsely, distributed elsewhere in Warringah Shire during this decade. The Fauna Protection Panel and Taronga Zoo received reports of Koalas at Mona Vale, Warriewood, Narrabeen, Brookvale, French's Forest and Cottage Point (Figure 1).

1960-1969

Concern over clearing of trees on Barrenjoey Peninsula continued through the 1960's. One resident of Newport, D. Sands, estimated that the total Koala population on the Peninsula was down to 50-60 (Sydney Morning Herald 20.ix.1962). Another Peninsula resident, D. R. Wilson, in a letter to the Fauna Protection Panel in 1964, stated that: "In areas where some years ago up to a

dozen animals could be seen during an evening, it is now possible to spend a week without seeing one" (by comparison, in 1989, Koalas are only seen at the best sites every 2-6 months). Responses to the 1989 questionnaire survey indicated that Koalas were regularly seen throughout the Peninsula in the 1960's (Figure 2). Koalas were even reported in 1967 from the small patch of woodland on Barrenjoey Head. It would seem, in fact, that 50-60 was an underestimate of the number of Koalas on the Peninsula at this time.

The New South Wales National Parks and Wildlife Service, the successor to the Fauna Protection Panel, carried out a State-wide Koala survey in 1967. Unfortunately, no report of the survey was prepared and most of the original data have now been lost, including all Warringah Shire records. However, other records of the New South Wales National Parks and Wildlife Service and Taronga Zoo show that, as in the 1940's and 1950's, Koalas occurred in scattered localities throughout the Shire in addition to Barrenjoey Peninsula: Bayview, Mona Vale, Deep Creek area, Collaroy, Dee Why, Davidson Park, Terrey Hills and various localities in Ku-ring-gai Chase National Park (Figure 1).

1970-1979

Koalas were common and widely distributed on Barrenjoey Peninsula in the early 1970's. A comprehensive survey was carried out by local conservationists in September 1970. Details are no longer available but summary figures sent to the New South Wales National Parks and Wildlife Service and recorded on the WILDATA wildlife inventory programme show an estimated total population of over 123 Koalas, distributed from Palm Beach to Mona Vale, with the greatest numbers in the Avalon-Careville area (Figure 2).

Williamson (1975) quotes an estimate of 100 Koalas on the Peninsula a couple of years later, based on counts by the Avalon Preservation Trust. In February 1979 it was reported that counts by the Trust over the previous eight years had indicated a drop in Koala numbers from over 100 to 26 (Sydney Morning Herald 1.ii.1979). The latter figure was apparently derived from a survey through Avalon Primary School in 1979, which reported a minimum population of 25 Koalas to the New South Wales National Parks and Wildlife Service (WILDATA wildlife inventory programme). A sudden population decline on the Peninsula during the 1970's is also indicated by a detailed set of Koala records from The Circle, Bilgola Plateau, 1971-1989 (Table 1). The frequency of records varied from year to year but was consistently higher from 1971 to 1976 than in any subsequent years.

Koalas were widely reported from Ku-ring-gai Chase National Park during the 1970's, particularly near the



Figure 3. Changes in tree cover, Barrenjoey Peninsula, 1946-1986. Shaded = uncleared forest and woodland; stippled = cleared land with moderate to dense tree cover; unmarked = cleared land with sparse tree cover, or uncleared heath and scrub.

Table 1. Koala records of N. Adams from his house in The Circle, Bilgola Plateau, Barrenjoey Peninsula.

Year	Number of days		total
	seen	heard	
1971	14	7	21
1972	21	7	28
1973	58	3	61
1974	22	5	27
1975	9	15	24
1976	23	5	28
1977	7	0	7
1978	6	0	6
1979	1	0	1
1980	3	0	3
1981	0	0	0
1982	2	0	2
1983	6	1	7
1984	10	0	10
1985	9	0	9
1986	8	0	8
1987	7	6	13
1988	0	0	0
1989	0	0	0

major waterways (Figure 1). In 1973 a resident of Cottage Point, J. Pengilly, reported to the New South Wales National Parks and Wildlife Service (North Metropolitan District records) that Koalas were always about his house and that he had seen up to 12 around Cottage Point. Elsewhere in Warringah Shire there was only a single Koala record for the decade: one seen north of Bantry Bay in 1979 (reported by a local resident, C. Jeffries, during the 1989 survey). There were no reports from the coastal suburbs south of Mona Vale where Koalas had been reported sporadically during each of the previous three decades. Nor have there been any subsequent reports from there. Koalas appear to have disappeared entirely from these suburbs.

1980-1989

Clearing of remnant bushland on Barrenjoey Peninsula has continued throughout the 1980's, although to a lesser extent than in the 1950's, 1960's and 1970's (Figure 3). Clearing of bushland in 1985 for the Pittwater Palms Retirement Village between Avalon Parade and Central Road was a controversial issue (Smith and Smith 1985; Jones 1985). Since 1986, the latest date shown in Figure 3, there has been some further clearing in the Therry Street/Wanawong Road area south of Careel Bay. There has also been a steady increase in the density of houses on the Peninsula during the 1980's as vacant blocks have been built on and large blocks subdivided. On the other hand, tree cover has improved in many previously cleared areas as garden and street plantings

have grown to maturity (compare 1977 and 1986 in Figure 3).

During the 1980's the Koala population on the Peninsula has continued to decline (Figure 2). We estimate that there are now only some eight Koalas remaining on the Peninsula (see below). There have been no reliable reports of Koalas from Palm Beach or Whale Beach since 1984. During the 1989 survey, several long-time residents of Palm Beach reported that Koalas were common there in the 1960's but were rarely seen after about 1970. They now appear to have gone from the entire northern section of the Peninsula, despite the extensive bushland remaining in McKay Reserve. Koalas have also apparently gone from the southern end of the Peninsula. There have been no reports from Mona Vale during the 1980's and only one from Newport south of Wallumatta Road: Bishop Street on one occasion in 1986. Several residents commented that there was once a group of Koalas living around Crescent Road and The Avenue but they disappeared from there during the 1970's.

In the 1960's, Koalas were reported from Barrenjoey Peninsula right through Bayview and Church Point to Ku-ring-gai Chase National Park (Figure 1). It is possible that there was some exchange of animals between the National Park and the Peninsula. That Koalas may travel such distances is shown by one that escaped from the Hallstrom Nature Reserve at Cowan in 1967 and was recaptured six months later at Brooklyn, about 17 km away (Sydney Morning Herald 28.ix.1967). During the 1970's and 1980's the Koala colony on the Peninsula has become increasingly isolated from that in the National Park.

The Koala colony in Ku-ring-gai Chase National Park is probably now the largest in Warringah Shire. However, this colony too appears to have declined during the 1980's. Reports from the National Park have been noticeably fewer than during the 1970's. The New South Wales National Parks and Wildlife Service's local Wildlife Recording System contains 32 records for the National Park and immediate vicinity in 1970-1979 but only 10 in 1980-1989, and the latter are much less widespread (Figure 1). One reason for this apparent decline may have been the extensive bushfires in the National Park in the late 1970's and early 1980's. Another possibility is an outbreak of chlamydiosis. The only report from Cottage Point in the 1980's was a male suffering from an eye disease, confirmed as chlamydiosis, which was taken to Waratah Park Wildlife Reserve for treatment but subsequently died (R. Perry, Waratah Park, pers. comm.).

Elsewhere in Warringah Shire, there have been a couple of reports from the vicinity of Davidson Park State Recreation Area and it is possible that another small

colony of Koalas persists in this area. A Koala was seen beside Mona Vale Road, just north of Davidson Park, in 1982 (reported to local NPWS office), although it may have wandered there from Ku-ring-gai Chase National Park. During the 1989 survey a local resident, C. Jeffries, reported hearing Koalas calling each spring from 1986 to 1988 near Rhonda Avenue, above Bantry Bay, at the southern end of Davidson Park State Recreation Area. This is near where a Koala was sighted in 1979.

BARRENJOEY PENINSULA COLONY

Distribution

All Koala records from Barrenjoey Peninsula in 1988 and 1989 have come from the centre of the Peninsula, from Newport Heights north to Careel Head (Figure 2). The pattern of recent Koala sightings suggests that four Council bushland reserves are acting as refuges for the remaining Koalas: Angophora Reserve/Hudson Park (19 ha), Stapleton Park (8 ha), Careel Headland Reserve (6 ha forested) and Crown of Newport Reserve (4 ha). A Koala was regularly sighted near another reserve, Algona Reserve (2.5 ha), until 1988 but has not been seen since then. Two of the largest areas of remnant bushland on the Peninsula are McKay Reserve/Dark Gully Park (26 ha) and the unnamed reserves around Bilgola Creek (17 ha), but there have been no reports of Koalas in or near these reserves for several years.

In the residential areas, Koalas were reported as wandering individuals or pairs at infrequent intervals, at best every 2-6 months. They occasionally stayed around the houses for a couple of weeks but usually only a day or two. A number of residents commented that in the past, when there were fewer houses and more bush in their vicinity, the Koalas tended to stay around for longer periods.

Many residents commented that Koalas were seen more often in residential areas in spring and summer than in autumn and winter. Some residents interpreted this as a seasonal movement from one side of the Peninsula to the other. However, the same pattern was

Table 2. Koala sightings on Barrenjoey Peninsula by season.

Survey	Spring	Summer	Autumn	Winter
Newton, April 1988	18	17	23	0
Brown and Adair, December 1988	34	33	4	8
This survey, August 1989	40	42	20	24
Total	92	92	47	32

Table 3. Koala records from Barrenjoey Peninsula, September 1988 – September 1989. All were of single Koalas unless otherwise noted.

Month	Locality	Notes
September 1988	Avalon Parade	large male
October 1988	Alexander Road Elouera Avenue Palmgrove Road Bilwara Avenue York Terrace	female with young
November 1988	Chisholm Avenue Avalon Parade Trentwood Park Ruskin Rowe Palmgrove Road The Pinnacle The Circle Lower Plateau Road	
December 1988	Patrick Street Elvina Ave (Avalon) Central Road Ruskin Rowe Palmgrove Road Dress Circle Road The Pinnacle Bilkurra Avenue Bilga Avenue Mirrabooka Street Prince Alfred Pde Grandview Drive	approximate date two adults
January 1989	Ruskin Rowe Palmgrove Road The Circle Grandview Drive	female with young two adults
February 1989	Gunjulla Place Hilltop Road Bilambree Avenue Loombah Street	female with young approximate date approximate date approximate date
March 1989	Alexander Road Whale Beach Road Wollstonecraft Ave	female with young approximate date, male, taken to Stapleton Park and released
April 1989	Lower Plateau Road Bilwara Avenue Central Road Wandeen Road	approximate date male grunting
May 1989	Brindisi Place Kevin Avenue	approximate date approximate date
June 1989	John Street Edwin Avenue	approximate date old, sick female, taken to Taronga Zoo, had to be destroyed
July 1989	Central Road Palmgrove Road Stapleton Park Avalon Parade Bilwara Avenue	
August 1989	Avalon Parade Katandra Close Ruskin Rowe Bilwara Avenue	large male female
September 1989	Lower Plateau Road	

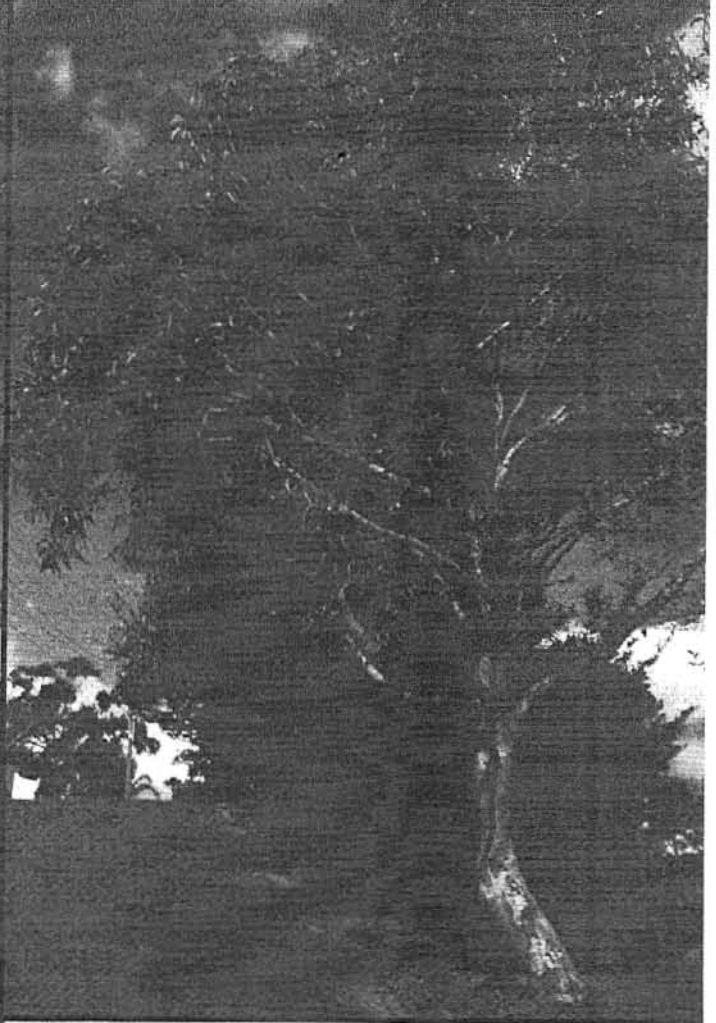
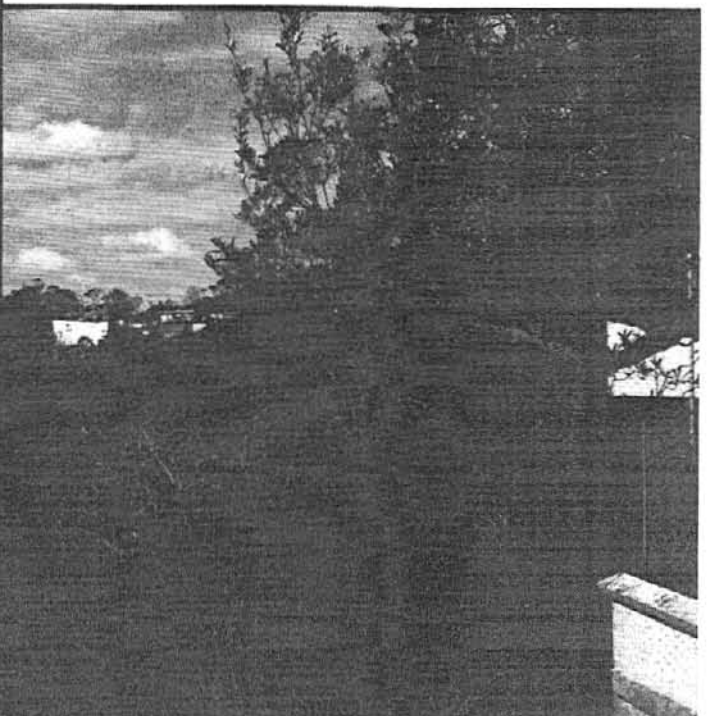


Photo 3. Grey Gum, *Eucalyptus punctata* Newport.

Photo 4. Scribbly Gum, *Eucalyptus haemastoma*, Bilgola Plateau.

Photo 5. Swamp Mahogany, *Eucalyptus robusta*, Newport.

Photo 6. Eucalypt dieback on the eastern side of Bilgola Plateau – there are large numbers of dead and dying eucalypts throughout Barrenjoey Peninsula along drainage lines receiving urban runoff. (Photos by Peter Smith.)



reported on both sides of the Peninsula (Table 2). It would seem that the Koalas wander less widely during the cooler months and keep to the bushier areas, where they are more difficult to detect.

Numbers

In the survey questionnaire form, all residents were asked to watch out for Koalas and report any sightings between 26 August and 3 September 1989. During this period we spent 15 hours over five nights in the most likely locations, spotlighting and listening for Koala calls. There were only two records for the period: a large male in Avalon Parade and possibly the same Koala in Ruskin Rowe. A female was seen in Bilwara Avenue two weeks before the survey period (8-10 August) and possibly the same Koala in Lower Plateau Road one week after the survey period (10-11 September). A report from Stapleton Park about a month before the survey period may have been a third Koala, possibly the male transferred there from Wollstonecraft Avenue in March (Table 3).

Considering all Koala records over the last year (Table 3), it is likely that there are more than just these three Koalas on the Peninsula, especially considering the pattern that emerged of Koalas being sighted more often in spring-summer than in autumn-winter (see above). We estimate that there are about eight Koalas in all (Figure 2).

Breeding

There have been several reports of successful breeding in the last two years. Females with young were reported in Ruskin Rowe-Trentwood Park-Avalon Parade in November 1987-February 1988 (several reports but all likely to be the same animals), Palmgrove Road in October 1988, Grandview Drive in December 1988-January 1989 and Whale Beach Road in March 1989.

Following the survey, on 24 September 1989, a sick female Koala was taken to Taronga Zoo from Wandeen Road (probably the same female reported nearby earlier in the month). This female, which was subsequently returned to the area in November 1989, was estimated to be 7-10 years old but showed no evidence of ever having bred.

Mortality

At least two adult Koalas have died over the last two years. In June 1989 an old, sick female was taken from Elvina Avenue (Avalon) to Taronga Zoo for treatment but had to be destroyed (autopsy: chronic colitis, starvation, senility). An adult male was found dead at Avalon in July 1988 and also taken to Taronga Zoo (autopsy: starvation, tapeworm infestation, senility). Another Koala,

not fully grown, was reported to be in poor condition in Raymond Road, near Algona Reserve, in 1988 - weeping eyes, sight affected, wandering about the road. These symptoms suggest chlamydiosis and it is unlikely that the animal has survived. It had been seen in the vicinity every few months before then but has not been seen since.

In their responses to the 1989 questionnaires, many residents suggested that dogs were the chief cause of death of Koalas on the Peninsula. One resident stated that he knew of at least eight Koalas being killed by dogs over the years. Although this may be an exaggeration, other, more specific records of Koala mortalities over the last 50 years (Table 4) also indicate that dogs are the single most important cause, accounting for 24-40% of deaths (taking account of the Koalas which died from injuries of unspecified cause).

Table 4. Causes of death of Koalas on Barrenjoey Peninsula, 1947-1989. Records of Taronga Zoo, Avalon Preservation Trust, New South Wales National Parks and Wildlife Service and reports from residents during 1989 survey.

Indications of cause of death	Number of Koalas
Injuries:	
Attacked by dogs	6
Hit by motor vehicles	2
Fell from tree	1 (destroyed)
Pneumonia after injury in Koala fight	1
Cause not specified	4
Very old koalas:	
Starvation, tapeworm infestation	1
Starvation, chronic colitis	1 (destroyed)
No other details	2
Possible <i>Chlamydia</i> -linked diseases:	
Cystic uterus	1 (1970)
Bladder trouble	1 (1963)
Other:	
Terminal aeromonas infection, ticks	1
Large ticks, pneumonia	1
Cryptococcal meningitis	1
Abnormal growths on head	1 (destroyed)
Poisoning attributed to <i>E. citrodora</i> foliage	1
Total	25

By comparison, motor vehicles accounted for 8-24% of deaths. Many respondents mentioned having seen Koalas crossing roads or on roadsides but few had seen or heard of them being hit by cars. There is still local concern over the threat posed to Koalas by motor vehicles but it is noticeably less than that expressed in 1938, when it was reported that five Koalas had been killed on the local roads over an 18 month period (Sydney Morning Herald 22.xii.1938).

In other urban Koala colonies which have been studied, motor vehicles have been identified as a more frequent cause of death than dogs. Records from Phillip Island, Victoria, indicated that about 60% of deaths were caused by motor vehicles and 6% by domestic dogs (Lee and Martin 1988). Figures from the Port Macquarie area were 30% of deaths caused by motor vehicles, 7% by dogs and other carnivores, and some 35% probably linked to chlamydiosis (Canfield 1987). The relatively fewer deaths from motor vehicles on Barrenjoey Peninsula may reflect the general location of Koalas away from the main thoroughfare, Barrenjoey Road, particularly in latter years (Figure 2).

The suite of diseases caused by the bacterium *Chlamydia psittaci* and collectively referred to as chlamydiosis are the most common diseases found in Koalas and include several severely debilitating forms (Brown and Carrick 1985; Brown 1986). The incidence of chlamydiosis in the Barrenjoey Peninsula colony has been generally low. There is some suggestion of its occurrence in the records of Koala deaths (Table 4) and in a report of a "mysterious eye trouble" in the population (Manly Daily 10.vii.1969). However, residents reported

that most Koalas seen over the years have appeared healthy. Recent reports of chlamydiosis in Warringah Shire have been referred to above: the Koala in Raymond Road in 1988 and the one a couple of years before at Cottage Point in Ku-ring-gai Chase National Park.

Food Tree Preferences

Almost all the *Eucalyptus* and *Angophora* species occurring on the Peninsula have been reported browsed, at least occasionally, by Koalas in other regions (Bergin 1978; Lee and Martin 1988). However, the local Koalas showed marked preferences for certain species. The frequency of use of each eucalypt species by Koalas was compared with its frequency of occurrence (Table 5). The statistical significance of the differences was examined by chi-square analysis. The Koalas showed significant preferences for three species. Particularly favoured was Grey Gum, *Eucalyptus punctata*, which constitutes only 5% of the trees on the Peninsula but about half the trees in which Koalas were seen. The preference of the Koalas for this species has long been recognized locally (e.g., Bulletin 17.ix.1958; Sydney Morning Herald 20.ix.1962) and it is a proven staple food tree (Cork *et al.* 1983; Cork 1986).

The other two species favoured by the Peninsula Koalas were Scribbly Gum, *E. haemastoma*, and Swamp Mahogany, *E. robusta*. Eucalypt species that were used less frequently than expected included Bangalay, *E. botryoides*, and probably Grey Ironbark, *E. paniculata*, both of which have been suggested before as important food trees on the Peninsula (Smith and Smith 1985; Adams 1990) and have often been planted for this purpose. It is worth noting, however, that a Koala was reported in 1967 on Barrenjoey Head, where the only eucalypt species seen was *E. botryoides*.

Table 6. Trees reported to be specially favoured by Koalas.

Species	Number of trees		total	%
	<15 m	>15 m		
<i>E. punctata</i>	8	23	31	82
<i>E. haemastoma</i>	3	2	5	13
<i>E. umbra</i>	1		1	3
<i>E. leucoxylon</i>	1		1	3

Of the 154 trees in which Koalas have been seen, 38 were reported to be specially favoured (Table 6). These were predominantly *E. punctata*. *E. haemastoma* was the second most important species and appears to be the principal food tree in some parts of the Peninsula from which *E. punctata* is absent. Where trees of the two species grow together, several residents reported that *E. punctata* was preferred to *E. haemastoma*. There were

Table 5. Tree species preferences of Koalas on Barrenjoey Peninsula. The frequency of occurrence of tree species on the Peninsula was sampled in 108 plots of 0.1 ha on a 375 m grid.

Tree species	Trees in which Koalas seen (%)	Trees on the Peninsula (%)	Chi-square tests
<i>Angophora</i>			
<i>costata</i>	2	11	*** (-)
<i>floribunda</i>	0	11	*** (-)
<i>Eucalyptus</i>			
<i>botryoides</i>	4	12	*** (-)
<i>gummifera</i>	5	9	NS
<i>haemastoma</i>	11	3	*** (+)
<i>maculata</i>	14	31	*** (-)
<i>paniculata</i>	3	6	NS
<i>pellita</i>	1	2	NS
<i>piperita</i>	0	1	NS
<i>punctata</i>	45	5	*** (+)
<i>racemosa</i>	0	<1	NS
<i>robusta</i>	7	3	*** (+)
<i>sieberi</i>	1	1	NS
<i>umbra</i>	1	2	NS
Introduced:			
<i>citriodora</i>	1	<1	NS
<i>leucoxylon</i>	1	<1	NS
<i>nicholii</i>	3	1	NS
<i>saligna</i>	0	1	NS
<i>sideroxylon</i>	1	<1	NS
other species	0	1	NS
Sample size	154	900	

NS not significant; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; + used more frequently than expected; - used less frequently.

also a number of reports, for both *E. punctata* and *E. haemastoma*, that certain individual trees were preferred to others nearby of the same species.

Food Tree Distribution

The eucalypt communities present on the Peninsula were classified on the basis of differences in tree species composition among the 80 sample plots with at least four endemic eucalypts (excluding plantings but not natural regeneration after clearing). Thirteen different communities were recognized (Table 7).

The three food trees favoured by Koalas are unevenly distributed among these eucalypt communities. They are concentrated in five communities, which may be considered the prime Koala habitat on the Peninsula:

1. *E. robusta* community. Associated with flat, low-lying areas on Quaternary alluvium (Geological Survey of New South Wales 1983; Herbert 1983), Warriewood soil landscape unit (Chapman *et al.* 1989; Chapman and Murphy 1989). Food trees: *E. robusta* 64%, *E. punctata* 14%.
2. *E. gummifera*-*E. haemastoma* community. Associated with plateaus on Hawkesbury Sandstone; Gynea and Somersby soil landscape units. Food trees: *E. haemastoma* 38%, *E. punctata* <1%.
3. *A. costata*-*E. maculata* community. Associated with sheltered slopes at the junction of Hawkesbury Sandstone (Hawkesbury soil landscape unit) and Newport Formation (Watagan soil landscape unit). Food trees: *E. punctata* 9%, *E. haemastoma* <1%, *E. robusta* <1%.

Table 7. Composition of the thirteen eucalypt communities on Barrenjoey Peninsula. Communities were identified from differences in tree species composition among sample plots with at least four endemic eucalypts. Community names indicate the one or two most frequent species.

	<i>E. botryoides</i>	<i>E. botryoides</i> - <i>E. maculata</i>	<i>E. botryoides</i> - <i>E. paniculata</i>	<i>A. floribunda</i> - <i>E. botryoides</i>	<i>A. floribunda</i> - <i>E. haemastoma</i>	<i>E. paniculata</i> - <i>E. punctata</i>	<i>E. maculata</i>	<i>A. costata</i> - <i>E. maculata</i>	<i>A. costata</i> - <i>E. botryoides</i>	<i>E. gummifera</i> - <i>A. costata</i>	<i>E. gummifera</i> - <i>E. haemastoma</i>	<i>E. gummifera</i> - <i>A. floribunda</i>	<i>E. robusta</i>
Number of plots	7	2	3	3	2	2	24	11	4	11	5	2	4
Composition (%):													
Koala food trees													
<i>E. punctata</i>	2					29	2	9		3	<1		14
<i>E. haemastoma</i>					30			<1	2	4	38	4	
<i>E. robusta</i>					3			<1					64
Other eucalypts													
<i>A. costata</i>	2	5					4	19	53	36	10		
<i>A. floribunda</i>	6	15	22	60	40	29	7	13	11	1		21	4
<i>E. botryoides</i>	88	50	42	30	15		2	10	19		2	5	18
<i>E. gummifera</i>							3	14	2	39	38	59	
<i>E. maculata</i>	2	30		5	9		70	16		1			<1
<i>E. paniculata</i>	<1		36		3	29	8	6	14	2			
<i>E. pellita</i>							1	6		3			
<i>E. piperita</i>								2		7			
<i>E. racemosa</i>	<1									<1			
<i>E. sieberi</i>											12		
<i>E. umbra</i>				5		14	3	5		4		11	
Tree height (%):													
6-15 m	61	45	100	86	97	79	37	76	78	84	96	99	41
>15 m	39	55	0	14	3	21	63	24	22	16	4	1	59
Tree health (%):													
healthy (<1/3 crown dead)	92	46	49	73	82	100	83	87	93	86	96	90	93
unhealthy	8	8	43	23	18	0	9	11	4	8	4	4	7
dead	0	46	8	4	0	0	8	2	3	6	0	6	0

Figure 4. Distribution of eucalypt communities on Barrenjoey Peninsula, 1989.

PRIME KOALA HABITAT

- 1 *E. ROBUSTA*
- 2 *E. GUMMIFERA-E. HAEMASTOMA*
- 3 *A. COSTATA-E. MACULATA*
- 4 *E. PANICULATA-E. PUNCTATA*
- 5 *A. FLORIBUNDA-E. HAEMASTOMA*

OTHER EUCALYPT COMMUNITIES

- 6 *E. GUMMIFERA-A. FLORIBUNDA*
- 7 *E. GUMMIFERA-A. COSTATA*
- 8 *A. COSTATA-E. BOTRYOIDES*
- 9 *E. MACULATA*
- 10 *A. FLORIBUNDA-E. BOTRYOIDES*
- 11 *E. BOTRYOIDES-E. PANICULATA*
- 12 *E. BOTRYOIDES-E. MACULATA*
- 13 *E. BOTRYOIDES*

EUCALYPTS PER HA

0 10-30 40-90 100-190 200-390 400-880

• • • • •

BUSHLAND RESERVES

- A MCKAY RESERVE/DARK GULLY PARK
- B CAREEL HEADLAND RESERVE
- C STAPLETON PARK
- D ANGOPHORA RESERVE/HUDSON PARK
- E BILGOLA CREEK RESERVES
- F CROWN OF NEWPORT RESERVE
- G ALGONA RESERVE

4. *E. paniculata-E. punctata* community. Associated with westerly slopes on Newport Formation geology, Erina soil landscape unit, at the base of the Peninsula. Food trees: *E. punctata* 29%.

5. *A. floribunda-E. haemastoma* community. Associated with ridges exposed to the sea, with a north-easterly aspect, on Hawkesbury Sandstone geology, Hawkesbury soil landscape unit. Food trees: *E. haemastoma* 30%, *E. robusta* 3%.

The distribution of Koalas on Barrenjoey Peninsula, both past and present (Figure 2), closely matches the distribution of these five communities (Figure 4) and of the three main food trees (Figure 5). The distribution of Koalas in 1988/89 corresponds to the distribution of the five communities at densities of over 100 eucalypts per ha (including residential areas with high numbers of remnant trees). Koalas have disappeared from areas of these communities which have been cleared to lower densities, in particular, an area of the *E. gummifera-E. haemastoma* community at Palm Beach and an area of the *E. paniculata-E. punctata* and *E. robusta* communities in the south-west of Newport. The two large bushland areas where there have been no Koala records in 1988 and 1989 (McKay Reserve and the Bilgola Creek reserves) do not contain any of the important communities, and nearby areas where the communities do occur have been cleared to densities below 100 eucalypts per ha.

Even the bushland reserves where there are still Koalas are a poor sample of their local habitat. Only one of the five eucalypt communities which represent prime Koala habitat is present in the larger reserves (Figure 4): the *A. costata-E. maculata* community in Stapleton Park and Algona Reserve. All the reserves have low numbers of food trees – in every reserve the ratio of food trees to other eucalypts is below the Peninsula average. Only three of the seven reserves have more than 10 food trees per hectare. One of these is the smallest reserve, Algona Reserve, and in the other two the main food tree is *E. haemastoma* rather than *E. punctata* (Table 8).

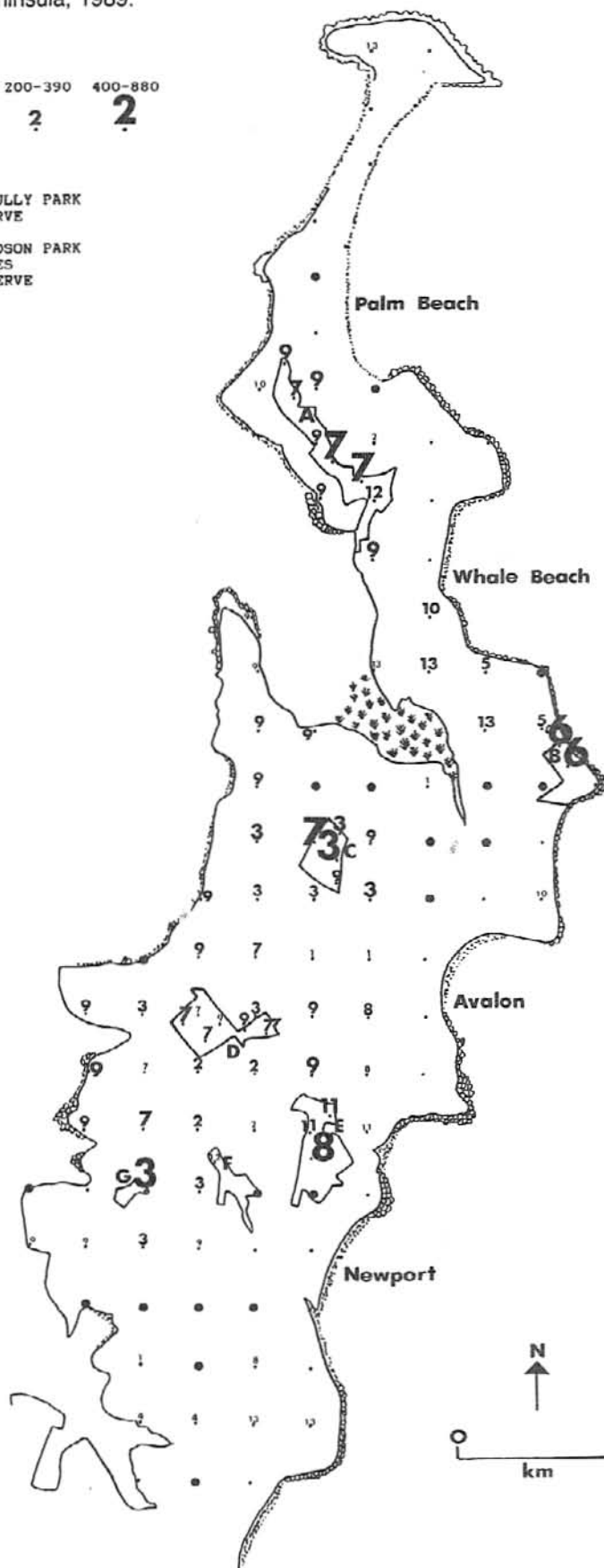
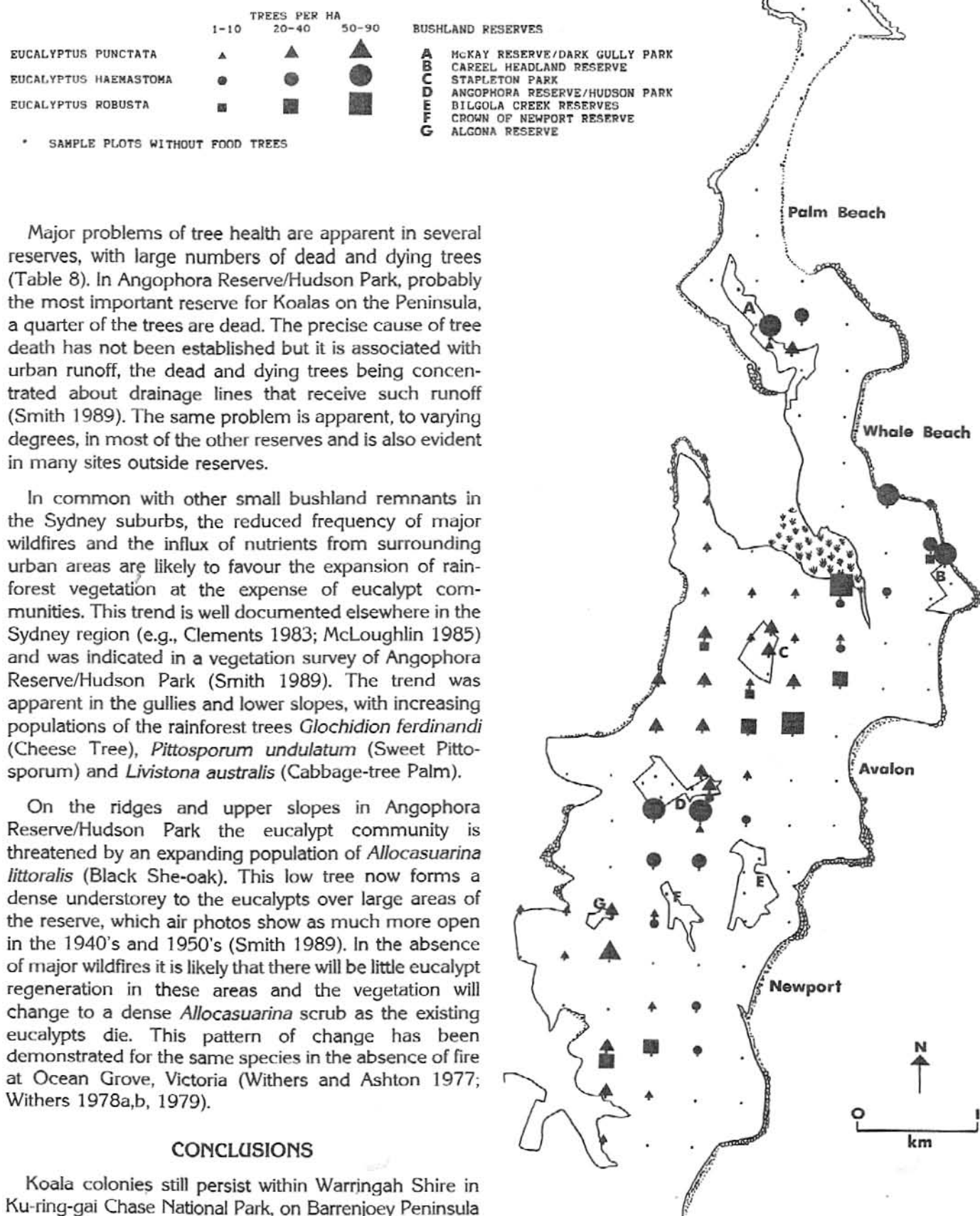


Figure 5. Distribution of Koala food trees on Barrenjoey Peninsula, 1989.



and possibly also in Davidson Park State Recreation Area. However, the history of Koalas in the Shire over the last 50 years has been one of dramatic decline, especially over the last 20 years. Even in Ku-ring-gai Chase National Park there have been fewer records of Koalas in recent years, which may be a consequence of severe bushfires and an outbreak of chlamydia, and certainly warrants further investigation and monitoring. The Koala colony on Barrenjoey Peninsula, the main subject of this study, was the largest colony in the Sydney area from the 1940's to the 1970's. In 1970 there were an estimated 123+ Koalas on the Peninsula. We estimate that only some eight Koalas now remain and the colony is in imminent danger of local extinction.

The demise of Koalas on the Peninsula follows clearing of their prime habitat (Figure 3). Some 47% of the Peninsula was forested in 1946 but only 8% is forested now, and the remnants are predominantly areas with low numbers of food trees. Despite retention and planting of many food trees in the urban areas, these remain a hostile environment for Koalas. Dogs and motor vehicles are major causes of mortality. Fences and walls impede movement from tree to tree. The present distribution of Koalas on the Peninsula suggests they are dependent on a number of Council bushland reserves, which act as refuges. In the urban areas themselves the Koalas appear at infrequent intervals and seldom stay for more than a day or two. Nonetheless, these visits may be essential,

Table 8. Eucalypt composition of the larger bushland reserves on Barrenjoey Peninsula. Crown of Newport Reserve includes a large patch of rainforest and hence has a low overall density of eucalypts.

	Barrenjoey Peninsula	McKay Reserve/ Dark Gully Park	Angophora Reserve/ Hudson Park	Bigola Creek reserves	Stapleton Park	Careel Headland Reserve (forested part)	Crown of Newport Reserve	Algona Reserve
Number of plots	108	6	6	4	4	2	2	1
Area (ha)	1515	26	19	17	8	6	4	2.5
Live eucalypts per ha	83	313	125	175	393	660	35	430
Koala food trees per ha	9	20	7	0	10	20	0	30
Composition (%):								
Koala food trees								
<i>E. punctata</i>	5	1	4		3			7
<i>E. haemastoma</i>	3	5	1			3		
<i>E. robusta</i>	3		<1					
Other eucalypts								
<i>A. costata</i>	11	19	23	30	36		14	32
<i>A. floribunda</i>	11	1	<1	19	15	21		12
<i>E. botryoides</i>	12	6	<1	23	3	5	57	28
<i>E. gummiifera</i>	9	33	33		23	60		2
<i>E. maculata</i>	31	21	23		13		29	5
<i>E. paniculata</i>	6	2	<1	28	1			9
<i>E. pellita</i>	2	3	<1					
<i>E. piperita</i>	1	6	5		2			
<i>E. racemosa</i>	<1							
<i>E. sieberi</i>	1							
<i>E. umbra</i>	2	3	10		4	11		
introduced species	3							5
Tree height (%):								
6-15 m	60	79	72	83	83	99	29	14
>15 m	40	21	28	17	17	1	71	86
Tree health (%):								
healthy (<1/3 crown dead)	84	87	67	73	93	90	29	84
unhealthy	12	4	9	20	4	4	21	14
dead	4	8	24	7	3	6	50	2

not only for movement between reserves but also because of the shortage of food trees within the reserves.

The chief threats to the colony are further loss of habitat — including eucalypt dieback and expansion of non-eucalypt vegetation within reserves — and further mortality from dogs, motor vehicles and chlamydiosis. Dogs appear to be the chief cause of death in this colony, whereas in other urban colonies studied, motor vehicles and chlamydiosis have been more important. The incidence of chlamydiosis on the Peninsula has been low but a 1988 report of a severely debilitated Koala, apparently suffering from the disease, raises the possibility of an outbreak that could rapidly eliminate the few remaining Koalas.

A number of actions should be taken to try and preserve the colony:

- Preservation of remaining patches of bushland outside reserves. The most important of these is the bushland strip running north-east from Hudson Park between Chisholm Avenue and Ruskin Rowe.
- Enhancement of reserves as Koala habitat. The capacity of the local reserves to support Koalas should be enhanced through judicious planting and care of food trees. Urban runoff to the reserves should be controlled and degraded areas regenerated. The likely expansion of rainforest and *Allocasuarina* scrub at the expense of eucalypt communities should be controlled.
- Preservation of existing food trees. Council's tree preservation policies should take special account of the three main local food trees, *Eucalyptus punctata*, *E. haemastoma* and *E. robusta*. Every effort should be made to preserve the remaining specimens.
- Planting of new food trees. There has been a long history of planting Koala food trees in the area. Unfortunately, this has often been less effective than it could have been through planting of unsuitable species, planting in unsuitable sites and insufficient care after planting. The emphasis should be on planting *E. punctata*. In sites unsuitable for this species, *E. haemastoma* or *E. robusta* should be planted. Distribution of young eucalypts to residents should be accompanied by information on where to plant these species and how to care for them until they become established. Plantings by residents should be matched by Council plantings in streets and parks. It is particularly important to increase the numbers of food trees in the vicinity of the bushland reserves and in corridors between reserves.
- Dog control. This will be crucial to the success of any attempts to preserve the colony. Losses of Koalas to dogs must be reduced. The threat is greatest from

large dogs and dogs working in packs. Dogs should not be allowed to roam free, particularly at night, when Koalas are most likely to be on the ground. More rigorous enforcement of the Dog Act is needed, and more frequent patrolling of the area. However, this should be accompanied by a public education programme. It is essential that residents be made aware of the threat posed by dogs and the need to restrain their pets. The larger, more aggressive breeds of dog should be discouraged.

- Control of motor vehicle speeds. Special low speed limits should be imposed on streets within the Koala distribution zone, with signposting to warn motorists of the presence of Koalas. Speed bumps should be introduced on the western sections of Avalon Parade and Central Road, where Koalas have been seen on the road a number of times in recent years.
- Allowance for Koala movements. Fences, walls and other constructions may form a barrier to Koala movements. In such situations, special allowance should be made for the Koalas to climb over or bypass the obstacle. For example, tree trunks or trunk-like poles located close to and on both sides of a fence would allow a Koala to cross over but not a dog.
- Treatment of sick Koalas. The local Koalas should generally be left alone but when one is obviously sick and distressed, Taronga Zoo should be contacted so that the animal can be taken for treatment and eventual return to the same site, a procedure which has operated in the area for a number of years.
- Population monitoring. A register of Koala sightings should be established and maintained, preferably with the involvement of the New South Wales National Parks and Wildlife Service. Residents should be made aware of the register and encouraged to contribute information. Full details should be obtained of any Koala deaths and the body sent to Taronga Zoo for autopsy. The timing of any future surveys of the colony should be November-December, when Koalas are seen more frequently in residential areas.

Further discussion of Koala management in urban areas, with particular reference to Barrenjoey Peninsula, is provided by Smith (1990, not the present author).

The history of the Koala colony on Barrenjoey Peninsula illustrates how a carefully planned and managed reserve system is crucial for Koala conservation in urban areas. This must be established in the early stages of regional development. The deficiencies of the reserve system on Barrenjoey Peninsula pose enormous difficulties for rehabilitation of the colony now. The likelihood of the Koala colony surviving on the Peninsula would have

been greatly increased had the reserves been located in the prime Koala habitat and designed and managed to prevent problems such as eucalypt dieback associated with urban runoff. Phillips (1990) has recently cited the Peninsula colony as an example of Koalas coping with urban development. We suggest it is more truly an example of them not coping.

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We pay a special tribute to Connie Adams, who worked tirelessly over many years to save the local Koalas, despite her declining health. Her recent death is a sad loss.

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BOOK REVIEWS

The Biology and Evolution of Australian Lizards

Allen E. Greer
Surrey Beatty & Sons Pty Ltd: Sydney
264 pages, RRP \$60

Australian snakes and lizards have become increasingly popular as the topic for general publications. Invariably, these books or magazines focus on the photogenicity of Australian reptiles. Large format, full colour, glossy folios have been the preferred mode to present Australian reptiles to a buying public. While this form of publication raises people's appreciation of these creatures they are rarely backed up by accurate or up-to-date biological information.

Unfortunately, the convention has been to dish up the same hackneyed collection of folk lore, supposedly to give the publication some biological credibility. Rarely is there any attempt to verify the information that is portrayed. The reason for this has been that often the authors of these articles have little expertise or experience with the animals that they write about. Myths and misinformation continued to be perpetuated in a time-honoured cycle.

1990 has seen a severing of the cycle. Allen Greer's "The Biology and Evolution of Australian Lizards" ignores the myths and concentrates on verifiable biological data. It is a fantastic compilation of information, gleaned from various sources including the normally unheralded band of amateur herpetologists who are bound to relish the contents of this book. Greer has attempted to synthesize data from widely different

scientific planes and to gel this into a realistic presentation about the biology of Australian lizards. Gaps in the data are pointed out.

"The Biology and Evolution of Australian Lizards" is not going to be everyone's "cup of tea". Not too many people, even those with a zoological bent, would lie awake at night thumbing through tables detailing lizard snout-vent lengths or listing the number of pre-sacral vertebrae for an impressive number of species. The book is heavily factual but it is surprisingly readable. Amateur and professional herpetologists will devour the contents with glee.

Greer's penchant for phylogenetics underlies his treatment of each major reptile group. In the same chapters are parcels of basic but important morphological details that give this publication the appearance of a textbook. To some extent that is what this book is. The author is clearly trying to set a standard for subsequent herpetological literature. Being true to his science, Allen Greer has liberally laced the text with extensive reference citations. The bibliography alone is informative and current. It is a pity that a number of small editing and printing errors exist in the text, but these have been detailed in the author's errata.

Some hackles will be raised through Greer's recognition and use of certain sensitive generic names. I do not see this as a drawback, but rather as a practical attempt to deal with a messy saga in herpetological systematics. Allen Greer has not been shy about recognizing the source of his data (or his systematic tags). This speaks heavily of his determination to be as objective as possible throughout the book.

In summary, Allen Greer has done Australian herpetology an enormous service. The book is certainly an accurate documentation of current knowledge in this area. It is bound to be a significant reference now and many years in the future. The contribution that this book makes to Australian zoology was recently recognized by the awarding of the 1990 Whitley Medal to Allen Greer and Surrey Beatty & Sons. No Australian herpetologist can afford to be without a copy.

Arthur White